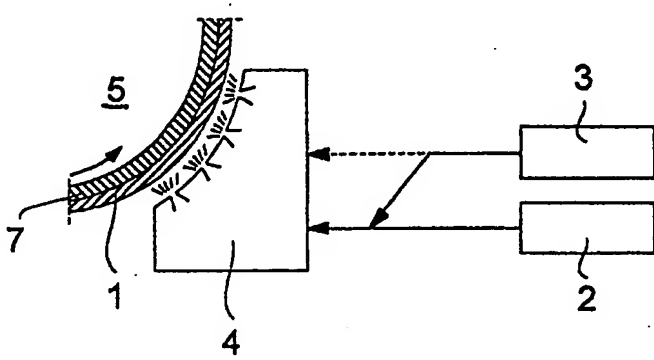


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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification <sup>6</sup> : <b>D21H 23/00</b></p>	<p><b>A1</b></p>	<p>(11) International Publication Number: <b>WO 99/13158</b> (43) International Publication Date: <b>18 March 1999 (18.03.99)</b></p>
<p>(21) International Application Number: <b>PCT/FI98/00669</b> (22) International Filing Date: <b>27 August 1998 (27.08.98)</b> (30) Priority Data: <b>973640 9 September 1997 (09.09.97) FI</b> (71) Applicant (for all designated States except US): <b>RUNTECH SYSTEMS OY [FI/FI]; Vehnöntie 492, FIN-41210 Jokihaara (FI).</b> (72) Inventor; and (75) Inventor/Applicant (for US only): <b>KARVINEN, Juha [FI/FI]; Helmipöllöntie 9, FIN-49220 Siltakylä (FI).</b> (74) Agent: <b>HEINÄNEN OY; Annankatu 31-33 C, FIN-00100 Helsinki (FI).</b></p>		<p>(81) Designated States: <b>AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</b></p> <p>Published With international search report. In English translation (filed in Finnish).</p>
<p>(54) Title: <b>METHOD AND APPARATUS FOR APPLICATION OF A TREATMENT AGENT TO A MATERIAL WEB</b></p> <p>(57) Abstract</p> <p>The present invention is related to a method of treating a material web in a paper or paper-board machine, in which method the moving web (1) is treated with a gas (2), particularly with steam. At least one supplementary treatment agent (3) is dosed into the stream of said gas and effected to travel along with said gas toward said material web. The invention also concerns an apparatus suited to implement the method.</p> 		

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Method and apparatus for application of a treatment agent  
to a material web

5 The present invention relates to a method according to  
the preamble of claim 1 for application of a treatment  
agent to a material web. The invention further concerns  
an apparatus according to claim 10.

10 In the art, different methods are known suitable for  
application of treatment agents (chemicals) on a web in a  
paper machine or similar equipment. For instance, an  
embodiment has been disclosed with an objective to aid  
the takeoff of the paper web from the intermediate roll  
15 of the paper machine press section by means of dosing a  
web release agent into the lubrication spray of the press  
roll doctor element. The desired goal of this arrangement  
is to facilitate a portion of the added agent to pass  
into the nip between the doctor element and the press  
roll, therein forming a film on the roll surface. The  
20 function of the film formed by the chemical additive is  
to aid the takeoff of the web from the roll surface by  
virtue of, e.g., lowering or increasing the surface  
tension of water, depending on the composition of the  
agent used. Among other disadvantages, this prior-art  
25 embodiment is handicapped by the following drawbacks.  
When operating properly, the doctor element cleans the  
roll surface free from all water, deposits and possible  
residues of the chemical additive so effectively that the  
roll surface after doctoring will be dry with no film of  
30 the chemical additive remaining thereon. The effect of  
the chemical will be minimal and the chemical losses  
high. By contrast, if the chemical is allowed to pass  
through the nip between the doctor element and the roll,  
the unavoidable corollary is that the doctoring effect  
35 must be reduced, whereby web breaks and production losses  
will be encountered in the paper mill. Broadly, conven-  
tional application methods misuse the potential effect of

chemical additives and frequently involve excessive consumption of the chemical.

5 It is an object of the present invention to provide an entirely novel arrangement for application of a variety of web treatment agents (chemicals) in a paper or paper-board machine. The goal of the invention is achieved by virtue of dosing the treatment chemical into the stream of a carrier gas such as steam and then applying the  
10 stream directly to the web surface via gas stream applicator device such as a steam box.

More specifically, the invention is characterized by what is stated in the appended claims.

15

The arrangement according to the invention has a number of significant benefits. Particularly, the treatment agent to be dosed can be carried in the gas stream with a high efficiency to the material web such as a paper web.  
20 The embodiment according to the invention can be used to accomplish a plurality of tasks. For instance, it can be employed in the dosing of a web release agent, whereby the agent is applied to the web prior to the intermediate roll from a steam box, for instance. Thus, a uniform film  
25 will be formed in the nip between the web and the roll surface, whereby the takeoff of the sheet from the roll becomes easier and safer than in the prior art. Thence, the web takeoff draw can be reduced to a minimum. Resultingly, no deterioration of paper web strength qualities  
30 will occur, because the web need not be tensioned for safe takeoff. Obviously, this leads to a reduced rate of web breaks and offers a potential margin of higher paper machine speed.

35

Moreover, the invention makes it possible to improve the efficiency of the paper machine press section by feeding a surface-tension-lowering agent into the injected steam.

Then, the steam condensing on the paper web will transfer the surface-active agent to the web, whereby the desired effect is attained as the surface tension of the water in the web is lowered allowing a greater amount of water to be drained from the web under compression. Resultingly, the solids content of the paper web increases and the amount of steam required for drying the sheet is reduced. This has an immense economical importance, because the consumption of drying steam forms one of the largest singular cost items in papermaking. Through the above-described procedure, it becomes possible to affect the final quality of the paper web by modifying, among other qualities, the surface properties or strength parameters of the sheet so that the paper will attain a higher strength, improved wet strength properties or higher quality. When the applied agent gives the sheet a higher strength, also the production capacity of the paper machine will rise. On the other hand, if the applied agent can improve the paper quality, it is an advantage to printing houses, thus elevating the retail value of the product. Furthermore, modification of the paper surface tension value will affect ink absorption, and thus, the quality of printing.

Additionally, the dosed agent may inherently have lubricating qualities, or alternatively, the dosed agent can be complemented with a lubricating additive such as a silicon- or teflon-based component. Thus, it is possible to reach the mechanical control means, such as the valves, of the gas feed means comprising, e.g., a steam box inasmuch said mechanical elements in conventional embodiments tend to stick due to deficient lubrication. Owing to improved lubrication of valves, the steam box may be utilized with maximum efficiency for attaining optimal moisture profiles of the paper web.

In the following, the invention will be examined in more detail with reference to the attached drawings in which

5 Figure 1 shows schematically one type of the press section of a paper machine;

Figure 2 shows schematically an embodiment according to the invention adapted to a point of use such as that  
10 illustrated in Fig. 1;

Figure 3 shows a dosing system of a first embodiment according to the invention; and

15 Figure 4 shows the dosing system of a second embodiment of the invention according to the invention.

The method is suited for treating a web in a paper or paperboard machine, whereby the method is used as illustrated in the drawings to treat a moving web 1 with a gas  
20 jet, particularly a steam jet. In conjunction with jet application of the steam 2 is introduced at least one supplementary treatment agent 3, which is adapted to impinge with the gas stream on the web 1.

25 The carrier gas 2 with the entrained treatment agent 3 is directed onto the web by means of a distribution/application device 4 such as a steam box. The treatment agent 3 is mixed with the carrier gas in the distribution/ application device (shown with a dashed line in Fig. 2) or in  
30 an inlet nozzle thereof.

The function of the treatment agent 3 is to affect at least one quality of the web 1, the properties of the web  
35 treatment devices, or both. The treatment agent can be in a gaseous, liquid or solid phase.

The application of the treatment agent is arranged to occur in a controlled manner. The state of the treatment agent is monitored and conditioned as required prior to feeding the agent into the gas stream.

5

The purpose of the treatment agent is to affect at least one of the following process qualities:

- web strength,
- web takeoff after the point of treatment from the
- 10 surface of an applicator element such as a roll,
- water removal from the web by virtue of, e.g.,
- affecting the surface tension properties, thus aiding the
- removal of water,
- surface properties of the web, and
- 15 - lubrication of the distribution/application device
- control means such as valves.

In present context, the term treatment agent is used in a broad sense also including effective combinations of a

20 plurality of such active agents.

The method and apparatus according to the invention are suited for use in conjunction with a paper machine press section, for instance, such as the one shown in Fig. 1.

25 In the diagram, only a partial view of the paper machine press section is illustrated. The press section shown in the diagram comprises a suction roll 5, an intermediate roll 6 and a steam box 4 adapted to direct the steam jet onto a paper web 1 led over the suction roll 5. Carried

30 on the underside of a so-called pick-up felt 7, the paper web 1 is led onto the suction roll 5. Next, the web is passed over the intermediate roll 6 and led across an unsupported run 8 over a guide roll 9 to a lead-off suction roll 10. Therefrom, the web travelling supported

35 on surface of the felt 11 is led to the next process step, e.g., to the next press section. In the press section shown in the diagram, the web is pressed against

the suction roll 5 and the intermediate roll 6 three times altogether in order to increase the solids of the web 1. The steam box 4 is a conventional component used globally in over 90 % of high-capacity paper machines. Steam boxes are described in, e.g., US Pat. No. 4,444,622 and US Pat. Ref. No. 28,968. By virtue of the steam box 4, the temperature of the paper web 1 can be elevated, while the surface tension of water is simultaneously lowered. Thus, water removal from the web is improved during the pressing step and the paper machine capacity is increased due to the higher web solids. The higher the process temperature is elevated with the process water circulations preferably being formed into closed systems, the more difficult will be the leading of the web across the unsupported run 8 from the intermediate roll to the paper web guide roll 9. This web removal from the intermediate roll 6 is called web takeoff. In the prior art, an improvement to web takeoff has been attempted by way of applying a chemical to the surface of the intermediate roll via the lubrication spray 13 of the doctor 12. As mentioned above, in this method the proper function of the doctor 12 prevents a sufficient amount of the chemical from reaching the nip between the web 1 and the roll 6 so as to form therein a web takeoff-improving film of the chemical. Now, the embodiment according to the present invention offers an essential advantage by overcoming this problem and others recognized in the art.

In an embodiment of the method according to the invention (refer to Fig. 2) uses a steam box 4 for applying a chemical 3 to the surface of a paper web 1 in order to form a chemical film aiding the takeoff of the web 1 from the intermediate roll 6. The steam 2 injected from the steam box 4 acts as a carrier gas for the chemical 3, whereby an extremely efficient transport of the chemical 3 to the surface of the paper web 1 is attained. Thus, the consumption of the applied chemical is minimized and, simul-



taneously, optimal effect in web release is achieved. By varying the properties of the applied chemical, an additional facility is provided for the control of water removal in the nips 2 - 4, lubrication of valves (not shown) in the steam box 4 and improved performance of the doctor 12. Depending on the properties of the chemical, it is further possible to modify the quality and strength properties of the sheet in a desired manner. Obviously, the use of the steam box 4 for the transport of the chemical 3 poses certain requirements for the chemical itself and the dosing system of the chemical. The steam box 4 or similar gas stream applying/distributing device may be located on the wire section, press section or dryer of the paper machine.

Next, the function of the method is elucidated with the help of an exemplifying embodiment. In the case that the takeoff of the paper web from the intermediate roll 6 (to an unsupported run 8) is problematic, the situation can be improved in a web-release-improving manner by feeding a small amount of a chemical 3A with qualities tailored to affect the properties of the sheet or the roll. Then, the chemical 3A will be transported along with the steam stream to the web surface forming there between the web and the intermediate roll surface a film that improves the takeoff release of the web from the roll surface. In this fashion, the risk of web breaks is reduced and the surface cleanliness of the intermediate roll is improved because of the reduced tendency of roll surface contamination by debris released from the web. Hence, the function of the intermediate roll doctor 6 is also improved. Correspondingly, into the steam stream can be dosed a chemical 3B having a lubricating effect on the control elements such as the valves of the steam box. A further application of the method is to dose into the steam entering the steam box a chemical 3C with properties acting on the surface tension of water, whereby the

chemical serves to modify the surface tension of water in the paper web so as to aid water removal from the web under pressure thus increasing the solids of the sheet at the outgoing side of the press section. Resultingly, energy saving will be gained in the dryer section of the paper machine. Moreover, the higher solids of the web makes the sheet stronger, whereby the risk of web breaks is reduced. Still further, the method according to the invention can be exploited by affecting the paper web with a chemical 3D capable of improving the surface qualities of the web and a web strength improving chemical 3E. Depending on the produced paper grade, desired effect of the chemical, the roll material, felts and other parameters, it is possible to formulate a combination of the chemicals 3A, 3B, 3C, 3D and 3E so as to obtain an optimal end result.

At least the following criteria can applied to define the necessary properties of the dosed chemical:

- must tolerate high temperatures (up to 200 °C) without undergoing an uncontrolled change of its composition
- must evaporate (become gaseous) with the evaporation of water, or alternatively, form an aerosol of extremely small droplet size when doses along with the steam stream into the steam box,
- must tolerate high pressures (up to 200 kPa) without changing its composition,
- during dosing, the temperature of the diluted chemical shall be brought as close as possible to the boiling point of water in order to avoid a temperature drop of the steam injected into the steam box and to attain a sufficient concentration of the chemical in the injected steam,
- no concentration or temperature variations of the diluted chemical are allowable, because the dilution and temperature control of the chemical must be carried out

in a controlled manner based on continuous measurement and control,

- no deviations from the continuous and smooth dosing of the diluted chemical are allowable, because the dosing of the chemical must be carried out in a controlled manner based on continuous measurement and control,
- the chemical can be in a gaseous, liquid or solid state such a pulverized material, and
- the carrier medium is a gas such as steam.

The invention also concerns an apparatus for treating a material web, said apparatus being suited to implement the method according to the invention and comprising a gas application/distribution device 4 such as a steam box adapted to direct and apply said gas 2, particularly steam, to a moving material web 1. The apparatus includes means for dosing at least one supplementary treatment agent 3 into the stream of said gas.

Further, the apparatus comprises means for conditioning said treatment agent prior to its dosing. Additionally, the apparatus may comprise means for diluting said treatment agent. Means for controlling the temperature of said treatment agent are included in said apparatus.

The apparatus further includes means for processing said treatment agent prior to its dosing. The apparatus may also include means for diluting said treatment agent. Means for controlling the temperature of said treatment agent are also included in the apparatus.

Referring to Fig. 3, therein is shown an embodiment of the apparatus according to the invention. The apparatus includes a conventional steam box 4, wherefrom the steam is directed from at least one opening against a continuously moving paper web. The steam is taken from a steam supply line 14 to a steam infeed pipe 15 of the steam

box. The steam infeed pipe 15 has a control valve 16 serving for the adjustment of steam pressure, volume rate or temperature. The steam infeed pipe is further provided with temperature measurement means 18 and pressure measurement means 17. These transmit steam pressure and temperature data to the control valve 16. Finally, to the lowermost point of the steam infeed pipe 15, close to the steam box 4, is made a condensate trap 19 into which the nonevaporated water is collected for drainage. A condensate drain valve is adapted to operate in conjunction with the condensate trap 19. For flawless function of the paper machine, it is crucial that no droplets of water shall enter the steam box 4, because such droplets if allowed to impinge on the web could cause holes in the web and even web breaks.

The steam temperature is generally controlled by injecting cooling water at an elevated temperature and free from dissolved gas to avoid corrosion and assure that the injected water will undergo evaporation prior to the infeed of the steam into the steam box. Such cooling water can be normal heated water, deionized water or condensate (condensed water) obtained, e.g., from the condensed steam of the steam circulation in the paper machine dryer section. In the illustrated embodiment, the cooling water is taken from a condensate container 20 used as a storage for the condensate of the steam circulation. From the container, the condensate is pumped by means of a pump 21 along a condensate infeed pipe 22 to the control valve 16 of the steam infeed pipe 15. To the condensate infeed pipe 22 are connected both a condensate return pipe 23 with a valve adapted thereto for protecting the pump 21 and a control valve 24 for regulating the volume rate of condensate infeed.

35

The dilution of the chemical 3 applied in the implementation of the method according to the invention may be per-

formed using either fresh water or as shown, e.g., condensate taken from the condensate container 20. The condensate is pumped by means of a pump 25 via a condensate flow-rate control valve 26 and condensate flow-rate transducer 27 to a mixing pump 32 of the chemical. The undiluted chemical is stored in a container 28. From the storage container, the chemical is pumped by means of a pump 29 via a chemical flow-rate control valve 30 and chemical flow-rate transducer 31 to a mixing pump 32 of the chemical. In the illustrated configuration, the mixing pump 32 performs mixing of the condensate with the undiluted chemical in an accurately measured and controlled ratio to a desired concentration. The concentration control is implemented with the help of the above-described flow-rate measurement means, control valves and metering pumps. By means of the mixing pump 32, the diluted chemical is moved along a diluted-chemical transfer pipe 33 via a valve 34 to a diluted-chemical storage container 35, or in some cases, directly into the steam infeed pipe 15. The diluted-chemical storage container 35 is provided with a heater element 41 serving to heat the chemical close to its boiling point. This arrangement assures immediate evaporation of the diluted chemical when injected into the steam infeed pipe 15 of the steam box. From the storage container 35, the diluted chemical is pumped by means of diluted-chemical metering pump 36 along the diluted-chemical dosing line 39 via a valve 37 and a flow-rate transducer 38 into the steam infeed pipe 15 of the steam box. Based on the signal of a temperature sensor 40 mounted on the diluted-chemical dosing line, the temperature of the chemical in the container 35 is adjusted with the help of the heater element 41. Based on the signal of the flow-rate transducer 38, the metered amount of the chemical is adjusted with the help of the metering pump 36.

In Fig. 4 is shown another dosing apparatus according to the invention. Therein, the diluted-chemical dosing line 39 exits into a steam-temperature-controlling water line 22 that further exits into the steam infeed pipe 15. The chemical dosing line may be connected to any point of the temperature-controlling water line 22 or directly to the storage container 20 of the liquid used for steam temperature control or to the return pipe 23 of the liquid. Alternatively, it is possible to dose the chemical directly into the steam supply line 14 or to the condensate line discharging into the storage container 20. Most advantageously, the chemical is dosed either directly to the steam infeed pipe 15 or a pipe connected immediately thereto, such as the steam-temperature-controlling water line 22.

In the above-described embodiments, the treating agent is used in the form of a liquid chemical, which is further diluted prior to its injection into the stream of the carrier gas 2. Alternatively, the treatment agent can be in a gaseous or solid state such as a pulverized raw material. Still further, a combination of such agents may be used. The treatment agent can be, e.g., a chemical exerting its effect via various cation/anion surface state charges or a low surface tension of the chemical. Further, the chemical may act as a lubricant and contain various silicon or fluorinated compounds.

To those versed in the art it is obvious that the invention is not limited by the exemplifying embodiments described above, but rather, can be varied within the scope and spirit of the appended claims.

## Claims:

1. A method of treating a material web in a paper or paperboard machine, in which method the moving web (1) is treated with a gas (2), particularly with steam, characterized in that at least one supplementary treatment agent (3) is dosed into the stream of said gas and effected to travel along with said gas toward said material web.
2. A method as defined in claim 1, characterized in that the stream of said gas (2) and said treatment agent (3) is directed toward said material web (1) by means of an application/distribution device (4) such as a steam box.
3. A method as defined in claim 1 or 2, characterized in that said treatment agent (3) is introduced into the stream of said gas in said application/distribution device or a nozzle connected thereto.
4. A method as defined in any of claims 1 - 3, characterized in that said treatment agent (3) is used to affect at least one quality of the web (1), the properties of the web treatment devices, or both.
5. A method as defined in any of claims 1 - 4, characterized in that said treatment agent (3) can be in a gaseous, liquid or solid state.
6. A method as defined in any of claims 1 - 5, characterized in that said treatment agent is dosed in a controlled manner.
7. A method as defined in any of claims 1 - 6, characterized in that the state of said

treatment agent (3) is monitored and conditioned prior to the injection of the treatment agent into the stream of the gas (2).

- 5 8. A method as defined in any of claims 1 - 7,  
c h a r a c t e r i z e d in that said treatment agent  
(3) is used to affect at least one of the following  
process qualities:
- strength of the web (1),
  - 10 - takeoff of the web (1) after the point of treatment  
from the surface of an applicator element such as a roll,
  - water removal from the web (1) by virtue of, e.g.,  
affecting the surface tension properties, thus aiding the  
removal of water,
  - 15 - surface properties of the web (1), and
  - lubrication of control means such as valves in the  
distribution/application device (4).

- 20 9. A method as defined in any of claims 1 - 8,  
c h a r a c t e r i z e d in that said treatment agent  
(3) is formulated into a combination of agents having  
different actions.

- 25 10. An apparatus for treating a material web, said appa-  
ratus comprising a gas application/distribution device  
(4) such as a steam box adapted to direct and apply said  
gas (2), particularly steam, to a moving material web  
(1), c h a r a c t e r i z e d in that said apparatus  
includes means for dosing at least one supplementary  
30 treatment agent (3) into the stream of said gas (2).

- 35 11. An apparatus as defined in claim 10, c h a r a c -  
t e r i z e d in that said dosing means comprise at  
least one dosing nozzle (39) connected to said gas appli-  
cation/distribution device (4) or to a nozzle connected  
directly to said device or to a nozzle (15) connected via  
another nozzle to said device, and further comprise at



least one control means (37) for controlling the dosed injection of said treatment agent into the stream of said gas.

- 5      12. An apparatus as defined in claim 10 or 11, characterized in that said apparatus further includes means for conditioning said treatment agent to be dosed prior to its dosing step.
- 10     13. An apparatus as defined in any of claims 10 - 12, characterized in that said apparatus includes means (20, 28, 32) for diluting said treatment agent (3).
- 15     14. An apparatus as defined in any of claims 10 - 13, characterized in that said apparatus includes means (40, 41) for controlling the temperature of said treatment agent (3).

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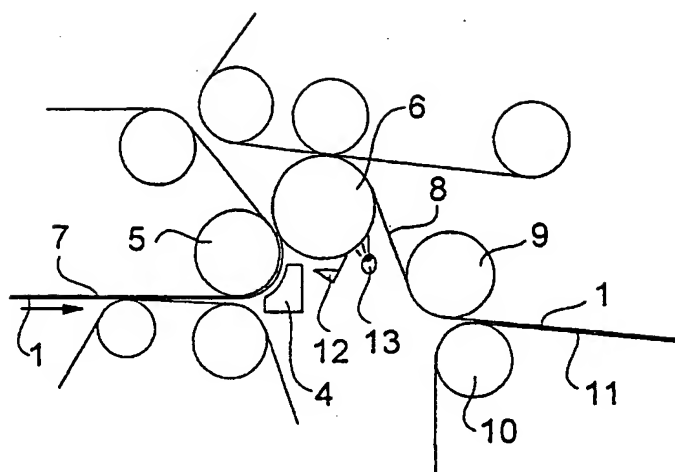


Fig 1

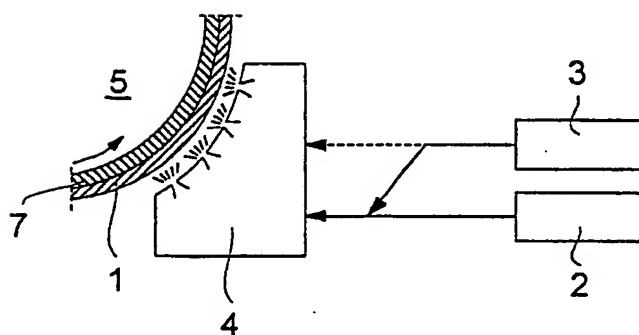


Fig 2

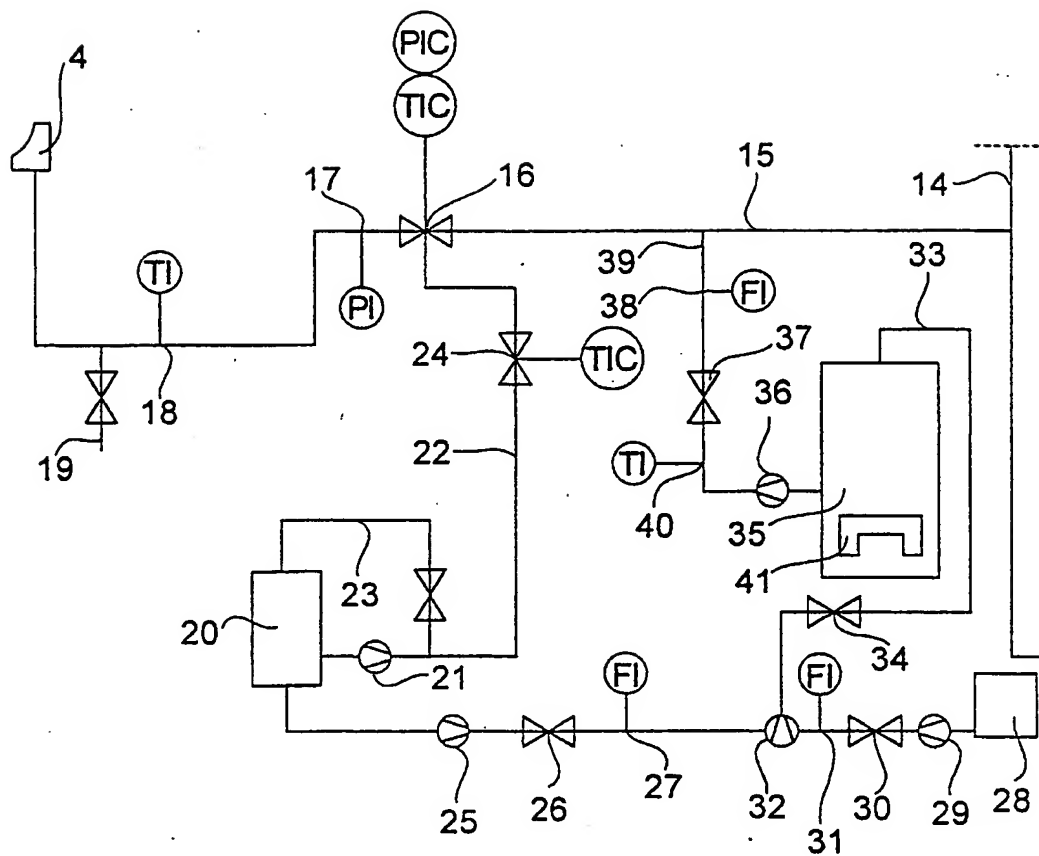


Fig 3

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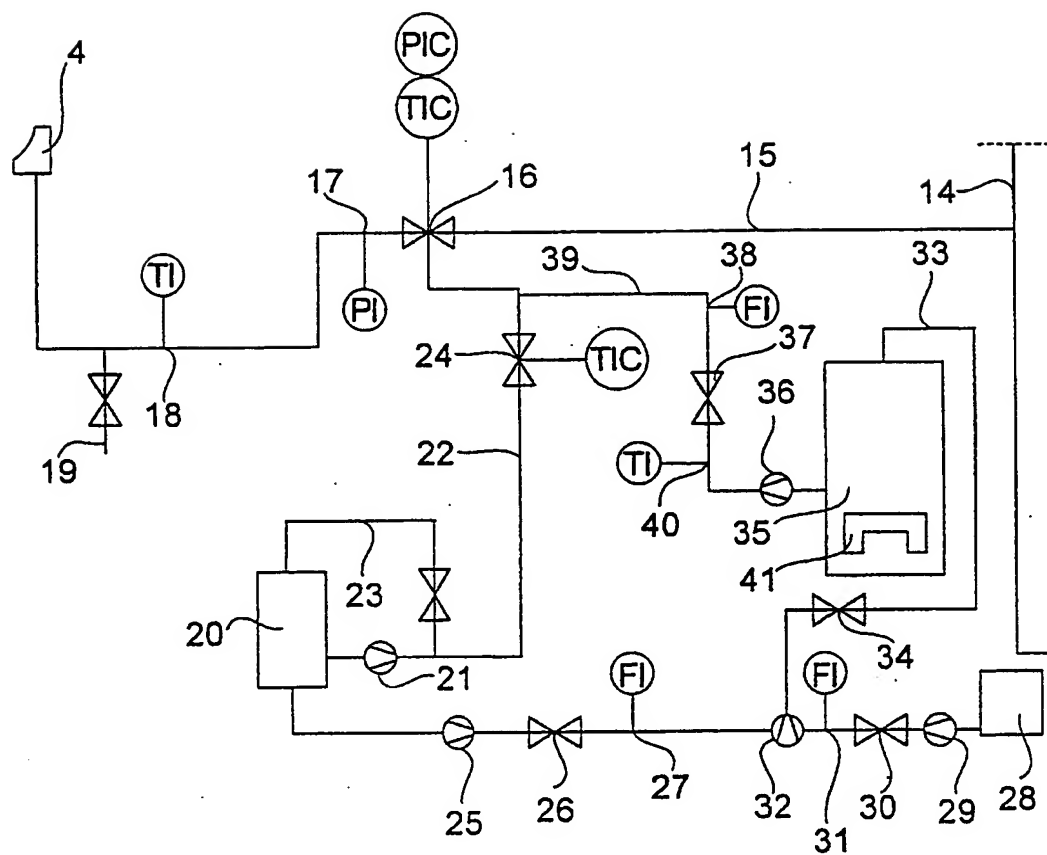


Fig 4

## INTERNATIONAL SEARCH REPORT

International application No. —

PCT/FI 98/00669

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: D21H 23/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: D21H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9411116 A1 (SUNDHOLM, PATRICK), 26 May 1994 (26.05.94), claim 1; page 3, lines 24-32; page 7, lines 8-12 --	1-14
X	EP 0659935 A2 (GLESECKE & DEVRIENT GMBH), 28 June 1995 (28.06.95), abstract --	1-14
X	WO 9513426 A1 (RAISIO CHEMICALS OY), 18 May 1995 (18.05.95), claims 1,4 --	1
X	US 4944960 A (PATRICK J. SUNDHOLM ET AL), 31 July 1990 (31.07.90), column 1, lines 36-41; column 2, lines 25-27; claim 1; abstract --	1-14

☒ Further documents are listed in the continuation of Box C.
 ☒ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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Date of the actual completion of the international search

10 December 1998

Date of mailing of the international search report

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## INTERNATIONAL SEARCH REPORT

International application No. —

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## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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